ART. VI.—CEREBRAL TOPOGRAPHY.

BY S. V. CLEVENGER, M. D.

LOCALIZATION in cerebral physiology and pathology, depending upon the composite nature of the brain, requires minute study of the shape and plan upon which this association or confederation of organs is arranged. Anatomy is indebted to Gratiolet and Leuret, not only for their investigations and accurate delineations of constant encephalic features, but for having reconciled and systematized the observations of their predecessors since the days of Aristotle.

An excellent article, by Pozzi, in the *Dictionnaire Encyclopedique des Sciences Médicales* (Paris), entitled "Circonvolutions Cérébrales," mentions the surprising want of uniformity among the older writers on anatomy, concerning the relative positions of these tortuosities of brain structure, and calls attention to a "figure of Spigel, *De corporis humani fabricâ*, lib. X., tab. 2." Pozzi ascribes this defect in anatomical books to the gross analogy, used by the authors, in likening the cerebral gyri to the *valvulæ conniventes* of the intestines.

This ignorance is not confined to the ancients, for on page 586 of Gray's *Anatomy* there occurs this passage: "There is no accurate resemblance between the convolutions in different brains, nor are they symmetrical on the two sides of the same brain." In a strict sense such a remark may be correct, but conveys an erroneous notion.

"Such authors," says the French encyclopedist, "are devoted to advancing the idea of the absolute variability in the disposition of the convolutions, the relative variability sufficing for a long time to justify prejudice against closer study."

The oldest works, of a precise character, on the cerebral anatomy of the primates (man and the ape) appear to be: Willis, "*Cerebri Anatome cui accessit nervorum, descriptio et usus*," London, 1664; Malpighi, "*De cerebro, et de cerebri cortice, opera*," London, 1686; Tyson, "*Orang-outang, sive*

Homo-sylvestris, or the anatomy of a Pygmie compared with that of a Monkey, an Ape, and a Man," London, 1699.

In the eighteenth century appeared *Cerebral Essays and Treatises* by Vieüssens, 1716; Ridley, 1725; Albinus, 1725, 9; Morgagni, 1741; Zinn, 1749; Tarin, 1750; Lorry, 1760; Malacarne, 1780; Vicq d' Azyr, 1781, 83, 86, 90; Soemmerring, 1788, 92, 96, 99; Rudolphi, 1796. At this period the more evident convolutions of simpler form were described by Vicq d' Azyr and Soemmerring, the lobulus fornicatus and the external parietal convolutions. In this present century followed works by Chaussier, 1807; Gall and Spurzheim, 1808, 9, 10; Doellinger, 1814; Gordon, 1815, 17; Tiedeman, 1816, 21, 36; Lauth, 1819; Burdach, 1819, 26; Reil, 1822, 23; Serres, 1824; Laurencet, 1826; Rolando, who in 1828, 31, in his "*Della struttura degli emisferi cerebrali. In memorie della Reale Accademia della sciege di Torino*," t. XXXV., p. 103, properly insisted upon certain fissures, and is said to have given a very exact description of the insula and "*processo anteroïdo cristato*," or lobulus fornicatus. Hertwig, in 1826, published "*Experimenta quædam du effectibus læsionem impartibus encephali*," anticipating the matter of localization in cerebral pathology.

Todd in 1847, wrote that Mayo (1827) had published "the best plates of the brain extant." Up to the time of Todd and Bowman's *Cyclopedia* the standard works on anatomy treating the subject, were those of Hildebrant, by Weber; Cruveilhier; Soemmerring, by Valentin; Meckel; Bell; Quain and Sharpey.

After Mayo, we have: Langenbeck, 1830; Arnold, 1838; Bourgery, Ribes, Leuret, 1839; Wilbrand, Baillarger, 1840; Van der Kolk, 1841; Parchappe, 1842; Foville, 1844; Todd, 1845; Burmeister, Stilling, 1846; Retzius, Solly, 1847; Ecker, 1851; Hirschfeld and Léveille, 1853; Huschke, 1854; Gratiolet, 1855, by whom a new era in encephalology was inaugurated; Krigma, 1855; Owen, 1857; Arnold, 1858; Ecker, 1859; Reichert, 1859, 61; Campen, 1859; Wagner, 1860; Huxley, 1861; Broca, 1861, 70, 71; Flower, 1862, 63, 64; Van der Kolk and Vrolik, 1862; Rolleston, 1862, 63; Wagner, 1862; Macleod, 1864; Barkon, Bradley, Lankester, Vogt, Turner, 1865; Pansch, Quain, Turner, 1866; Meynert, 1867; Bischoff, Ecker, Pansch, 1868; Ecker, Alix, 1869; Bateman, Broadbent, Gromier, Calori, Jensen, 1870; Nitsche, Sappy, Lussana and Lemoigne, Henle, 1871; Gromier, Bischoff, Gervais, Tuke and Fraser, Major, Hitzig, Mierzejewski, Schüle, Wernher, 1872; Turner, Mivart, Huguenin, Ferrier, 1873; Gromier, Darwin, Pozzi, Maliniverni, 1874; Charcot, 1875; Richet, 1878; Pansch, 1879; not including those writing upon comparative anatomy, prominent among whom were Serres, 1824; Desmoulins, 1825; Leuret, 1839; Rymer-Jones, 1841; Carus, 1853; Owen, 1857; Luys, 1865; Stieda, 1870; Huxley, 1871; Meynert, 1872; Ferrier, 1873.

Pozzi, p. 340, *op. cit.*, says:

"Nous devons à l'anatomie comparée d'avoir débrouillé le chaos apparent des circonvolutions chez l'homme. Les premiers pas avaient été faits dans cette voie dès la plus haute antiquité. Erasistrate écrivait: Les circonvolutions sont plus nombreuses dans l'homme que dans les animaux, parce que l'homme l'emporte sur les animaux par l'esprit et par le raisonment. A quoi Galien répondait: Je ne partage pas cet avis, car d'après cette règle, les ânes étant des animaux abruptis et stupides, ils devraient avoir un cerveau tout à fait simple, sans aucun sillon on sinuosité, tandis qu 'ils ont beaucoup de circonvolutions." (*De usu partium*, lib. 8, chap. 13.)

"Mais il a fallu de longs siècles pour que l'idée d'Erasistrate servît de guide à l'anatomie humaine."

This paper has for its object the suggestion of a rational scientific nomenclature for the exterior cortical portion of the brain. The necessity for this becomes apparent when examining the literature of the subject, rapidly assuming voluminous proportions as its importance grows evident to students. The synonyms given display at once the difficulties encountered in applying the topographical terminology of one author to the text of another. Ecker, Turner and Huxley have done much to simplify and systematize the names of the convolutions and fissures, but the recent monograph of Pansch, of Kiel, entitled "*Furchen und Wülste am Grosshirns des Menschen*" (1879), indicates a system which in most respects is very desirable, and which in the main is followed in this essay. Wherever a departure is made from his scheme the warrant for it is found in the accepted usages of other investigators. In beginning this compilation I greatly underestimated the amount of labor it would involve; but if it proves useful in tending toward improvement upon the systems heretofore prevalent, I shall feel fully justified in having undertaken it.

THE PLAN.

Owing to the difficulty of properly classifying the convolutions into groups or lobes, such divisions can be of a general character only; and instead of laboriously manufacturing limits for lobes, the more rational method is the natural one of *Surfaces.* We have then the *External* or convex; the *Median* or plane, and the *Basilar* or inferior *Surfaces* of the brain. An arbitrary subdivision into lobes may now be made, for convenience in general reference, separating the external and median surfaces into *Frontal*, *Parietal*, *Occipital* and *Temporal Lobes*; the sulcus Rolando between the frontal and parietal and the fissura Sylvii bounding the temporal lobe, superiorly. The basilar surface can be divided in the same indefinite manner into *Occipital*, *Temporal*, and *Frontal Lobes.*

Pozzi objects strongly to the use of either lobes or lobules in the nomenclature, but as objections can be urged against any selection of terms for portions of the cerebrum, let us select the most convenient and proceed. Probably a better understanding can be reached by defining the terms mentioned above with those to follow:

Surfaces: Natural divisions of the cerebrum into External, Median, and Basilar.

Lobes: Arbitrary divisions of the surfaces into Frontal, Parietal, Temporal, and Occipital.

Lobules: Portions included between fissures or sulci, heretofore styled convolutions, gyri, meandri, processi, plis, circonvolutions, volutions, lobes and lobules.

Gyri: Indivisible or lesser divisions of the lobules, possessing noteworthy relations, shape, or character, bearing something of the relationship to lobules the atom does to the molecule, at present having no designation apart from lobules, convolutions, etc.

Fissuræ: Primary, somewhat deep, constant clefts or furrows, associating man with animals of inferior intelligence. Sulci has been used interchangeably with fissuræ, to designate the same furrows before Pansch's late work.

Sulci: Lesser cortical fissures or furrows constant in the adult human brain.

Sulculi: Inconstant or little sulci, or furrows having no regular location or relationship to the convolutions.

Rami: Constant branches of fissuræ or sulci.

Extremitates: Useful in designating parts otherwise illy defined, because the sulci break up into forks and sulculi on reaching the extremes of the hemispheres. Prof. Pansch uses three divisions: *Extremitas orbitalis; Extremitus temporalis; Extremitas occipitalis.* The latter is the least useful, owing to the clustering of gyri fully occupying that region. It is not possible to exactly define these extremities, but they may be considered as including parts dubiously divided by the terminations of sulci.

FISSURÆ.

1. FISSURA LONGITUDINALIS.

Synonyms: f. or scissura cerebri longitudinalis; superior longitudinal sinus; f. c. l. superior, inferior et horizontalis posterior; interlobular f.; f. magna cerebri; interhemispheric f.

2. FISSURA SYLVII. (Cum ramus ascendens [et ramus anterior horizontalis, Pansch]).

PANSCH: f. sylvii mit ram. anterior horizontalis und ram. ant. ascendens.
ECKER: f. s., mit ram. ascendens s. anterior und ram. posterior s. horizontalis.
BISCHOFF: Stamm vorderer senkrechter Ast und hinterer horizontal aufsteigendes Ast der sylvischen spalte.
HENLE: f. lateralis posterior et anterior.
BROCA: scissure de s., branche antérieure et branche àscendente.
TURNER: f. of Sylvius w. horiz. and asc. limb.
GRATIOLET: fossa de Sylvius.
POZZI: scissure de Sylvius.
LUSSANA and LEMOIGNE: scissura di Silvio.
RICHET: scissure de Sylvius.
VARIOUS: fissure or fossa sylvii, fissura anterior; f. ant., inferior et externa; f. inferior; f. transversæ.

Entitling this fissure a fossa is in favor with some, and for this there is some reason, especially when its borders are separated so as to bring into view the Insula. But the word *fissure*, implying nothing as to depth, and designating this great seam better *in situ*, seems more appropriate. Ecker and Pansch differ concerning what parts should be called rami, while Turner attaches the ramus ascendens to the præcentral sulcus, in which he is not imitated by other authors.

3. FISSURA OCCIPITALIS.

PANSCH : fissura occipitalis.
ECKER : f. parieto-occipitalis pars medialis et lateralis.
BISCHOFF : f. occipitalis perpendicularis interna.
HENLE : f. occipitalis perpendicularis.
BROCA : scissure occipitale.
TURNER : parieto-occipital fissure, interna et externa.
HUXLEY and CHARCOT : the same as Turner.
GRATIOLET : scissure occipitale int. et ext.-occipito-parietale.
L. e LEMOIGNE : scissura perpendicolare.
FERRIER : parieto-occipital fissure.
FOVILLE : scissure posteriore.

There would be more warrant for attaching the occipital to the sulcus parietalis than the parietal to the fissura occipitalis, for it terminates in the human brain before fairly becoming parietal. The extra lateral development of this fissure in the apes is sufficiently posterior to justify retaining the word occipital, wherever occurring.

4. FISSURA CALCARINA (cum rami ascendens et descendens.)

PANSCH, ECKER, FERRIER, TURNER, HUXLEY : fissura calcarina.
BISCHOFF : f. hippocampi.
HENLE : f. occipitalis horizontalis.
BROCA : scissure calcarine.
FOWLER'S CHARCOT : calcarine fissure.
L. e LEMOIGNE : scissura occipito-parietale interna.
GRATIOLET : scissure interne, s. des hippocampes.
RICHET : scissure en pied de cheval, branche superieure et branche inferieure de la meme.

This important fissure has been, by some of the older writers, shortened by conferring its anterior portion upon the fissura occipitalis; it has been amplified by others, who have included the occipital with it; and omitted still by others, who consider it as a ramus of the occipital.

The name *calcarine*, from its marking the position internally of the calcar avis or hippocampus minor, would be preferable to "interne" of Gratiolet, as too indefinite, or "hippocampi" of Bischoff, as the larger hippocampus might mislead in locating it.

5. FISSURA HIPPOCAMPI.

PANSCH, ECKER, FOWLER'S CHARCOT, HUXLEY : fissura hippocampi.
BROCA : rainure du grande hippocampi.
TURNER : dentate fissure.
RICHET, FERRIER : sulcus hippocampi.

The dentate of Turner, referring to the fascia dentata, seems to other investigators to have less claim than hippocampus major, after which they have named the fissure.

These five fissures constitute the primary constant and deep separations of the lobules of the human brain, and they link bimana to quadrumana, across the artificial division of Owen, which placed man as an order of mammalia in the sub-class archencephala; the ape standing at the head of the gyrencephala.

Classification by zoological persistence would require the introduction of rudimentary or assumed fissures possessing a remarkable constancy in types lower than man. Lussana and Lemoigne have attempted this in locating a small "solco inflesso" anterior to the sulcus Rolando to mark the carnivoral crucial sulcus. The olfactory and calloso marginal sulci would merit distinction as fissures in many instances on the typical plan. We are, however, to seek the convolutions of the human brain, and, conforming to Pansch, the cortical fissures become sulci.

Among primary or constant typical furrows of the cortex the first sulcus is the sixth in order.

6. SULCUS ROLANDO.

ECKER : sulcus centralis.
BISCHOFF : s. centralis, s. Rolando.
BROCA : scissure de Rolando.
HUXLEY : postero-parietal sulcus.
HENLE : sulcus centralis.
HUGUENIN : fossa Rolandi.
PANSCH (formerly) : fissura transversa anterior.
TURNER, FERRIER, FOWLER : fissure of Rolando.
LUSSANA e LEMOIGNE : scissura di Rolando.
RICHET : scissure de R.
GRATIOLET : sillon de R.

"Die Rolando'sche Furche ist die constanteste und am frühsten auftretende unter den Primärfurchen der lateralen Fläche, und bei den Primaten überhaupt die am meisten charakteristiche." (*Furchen und Wülste, von Pansch,* 1879.) This sulcus makes its appearance in the fifth month of fœtal life. Pansch writes that it is by " Henle: unbennant," but I find it as "sulcus centralis" on page 161 of Henle's "*Nervenlehre.*"

7. SULCUS PARIETALIS.

ECKER : sulcus inter-parietalis.
PANSCH : sulcus parietalis.
BROCA : sillon parietal.
TURNER, HUXLEY, FERRIER : intra-parietal fissure.
RICHET : sillon interparietal.
LUSSANA e LEMOIGNE : scissura intermedia.
VARIOUS : s. postcentralis, s. postrolandicus.

8. SULCUS PRÆCENTRALIS.

PANSCH : sulcus frontalis (posterior division).
ECKER : sulcus præcentralis.
BROCA : sillon prerolandique.
TURNER : ascending limb of sylvian fissure.
FOWLER : vertical frontal fissure.
HUXLEY : antero-parietal.
LUSSANA e LEMOIGNE : solco ascendenti.

I think, in this instance, Ecker's name should be retained, because it expresses its position accurately. Pansch has joined this sulcus to the inferior frontal, just as Turner blended the ascending sylvian ramus with the same sulcus, and, as the older anatomists once caused trouble to their readers by calling the calcarine and occipital fissures "the perpendicular and its branches," the older name, præcentral, should remain. This greatly modifies the divisions into lobules Pansch suggests for this vicinity, and gives us the older designations for them also.

9. SULCUS FRONTALIS SUPERIOR.

PANSCH, ECKER: sulcus frontalis superior.
BROCA, RICHET: premier sillon frontal.
TURNER, HUXLEY, et als.: supero-frontal sulcus.
FOWLER: supero-frontal fissure.
LUSSANA e LEMOIGNE: scissura di verga.
VARIOUS: sulcus præcentralis superior, s. prerolandicus.

10. SULCUS FRONTALIS INFERIOR.

PANSCH: sulcus frontalis (anterior division).
ECKER: s. frontalis inferior.

BROCA: sillon second frontal.
TURNER, HUXLEY: infero-frontal sulcus.
FERRIER: inferior frontal.

11. SULCUS TEMPORALIS SUPERIOR.

ECKER: sulcus temporalis superior.
PANSCH: sulcus temporalis.
GALTON'S ECKER: first tempero-sphenoidal.
BROCA: premier sillon temporale.
TURNER: parallel fissure.
RICHET: sillon parallele.
GRATIOLET: scissure parallele.
HUXLEY: superior temporo-sphenoidal f.
FOWLER'S CHARCOT: superior temporal fissure.
LUSSANA e LEMOIGNE: scissura parallela.
BISCHOFF: fissura parallela s. temporalis sup.

12. SULCUS TEMPORALIS MEDIUS.

ECKER: sulcus temporalis medius.
BISCHOFF: fissura temporalis medius.
BROCA: deuxième sillon temporal.
TURNER: second tempero-sphenoidal fissure.
FOWLER'S CHARCOT: middle temporal fissure.
RICHET: represented in wood-cut, but unnamed.

Pansch ignores this sulcus and the succeeding one, but it is too well marked by Leuret and Gratiolet, especially in planche XXI., and in the engraving of the Encephale de Fieschi, planche XXII. It corresponds to the inferior temporal sulcus of the simians, tolerably well marked in the Cynocephalus sphinx, and fully in the macacque.

The omission of either of the lower temporal sulci would leave the included lobules or gyri without boundaries; and as all authors, including Pansch, give three temporal convolutions, this sulcus, in the present condition of our literature, should be retained. It however might be classed in Pansch's Zweifelhafte Primärfurchen.

13. SULCUS TEMPORALIS INFERIOR.

Writers associate this sulcus or sulculus with the preceding, consistently with whichever order they may have adopted, as troisième, inferior, etc. It lies between the preceding and the sulcus collateralis. It is neither so well defined nor so long as the medius, but it is either directly or inferentially mentioned by all but Pansch, who, nevertheless, makes mention of lobules which require it as a boundary. This sulcus might be considered as of doubtful constancy. In any event, it could be compounded of sulculi, and retained until its existence is discredited.

14. SULCUS COLLATERALIS.

PANSCH, ECKER: sulcus occipito-temporalis inferior.
BISCHOFF: fissura collateralis s. temporalis inferior.
HUXLEY: fissura collateralis.
BROCA: quatrième sillon temporal.
TURNER: collateral fissure.
FOWLER: s. occipito-temporalis lateralis.
LUSSANA e LEMOIGNE: scissura occipito-temporale.

This sulcus corresponds in position with the pes accessorius or eminentia collateralis, between the hippocampi, where the posterior and descending cornu join. This relationship being noted by the older anatomists, though they did not name the sulcus, justifies the choice of Huxley, Turner and Bischoff, and certainly has the merit of brevity, which other suggested titles have not.

15. SULCUS OLFACTORIUS.

This is uniformly called olfactory sulcus by all except Broca, who prefers "premier sillon orbitaire." It divides the gyrus rectus from the middle orbital gyrus.

16. SULCUS CALLOSO-MARGINALIS.

ECKER: s. c.-m.
PANSCH: s. c.-m. and s. medialis fronto-parietalis.
BROCA: scissure sous frontale.
TURNER: calloso-marginal fissure.
GRATIOLET: grand sillon du lobe fronto-parietale.
FERRIER, HUXLEY, RICHET: s. c.-m.
LUSSANA e LEMOIGNE: scissura crociata o. parietale interna.

The position of this sulcus above the corpus callosum, beginning under the genu, and coursing below the upper hemispheric margin, ending behind the sulcus Rolando, justifies the name, and is in most favor with anatomists.

17. SULCUS OCCIPITALIS TRANSVERSUS.

FERRIER: s. o. t.

Generally portrayed as a ramus at the lower end of the fissura parietalis. It is important as a means of bounding Gratiolet's *plis de passage* on the occipital extremity.

18. SULCUS ORBITALIS.

ECKER: sulcus orbitalis.
FERRIER: orbital sulcus.
FOWLER: orbital sulcus.
HENLE: indicated.
GRATIOLET: sillon de la face orbitaire du lobe frontal.
LUSSANA e LEMOIGNE: solco orbitale.

While Pansch omits this, the Italians designate one in addition. Most authors divide the orbital lobe into three convolutions, the boundaries of which are determined by this and the olfactory sulcus.

19. SULCUS OCCIPITALIS LONGITUDINALIS INFERIOR.

This small sulcus is between the second and third occipital gyri. *Occipitalis minor* might be more suitable; but abstaining from any contribution to the overburdened vocabulary, I give Ecker's choice.

SULCULUS PARACENTRALIS TRANSVERSUS.

A constant furrow found in the paracentral gyrus of Betz, and called by him the transverse furrow of the paracentral lobule.

PRIMARY OR CONSTANT CONVOLUTIONS.

A. EXTERNAL SURFACE.

I. LOBULUS FRONTALIS SUPERIOR.

PANSCH: gyrus frontalis superior.
ECKER: erste Stirnwindungsgruppe, gyrus frontalis superior.
HENLE: oberster gyrus frontalis.
HUXLEY: gyrus supero-frontal.
BROCA: première circonvolution frontale.
TURNER: superior frontal gyrus.
HUGUENIN: dritte stirnwindung.
VALENTIN: gyrus adplicatus anterior.
LUSSANA e LEMOIGNE: circonvoluzione parietale anteriori.
FERRIER: superior frontal convolution.
FOWLER'S CHARCOT: first frontal convolution.
RICHET: première circonvolution frontale.
GRATIOLET: première circonvolution frontale.

II. LOBULUS FRONTALIS MEDIUS.

PANSCH: gyrus frontalis medius.
BISCHOFF: zweite Stirnwindungsgruppe.
HENLE: mittlerer gyrus frontalis.
BROCA: deuxième circonvolution frontale.
TURNER: middle frontal gyrus,
HUGUENIN: zweite Stirnwindung.
LUSSANA e LEMOIGNE: circonvoluzione circolare.
FERRIER: middle frontal convolution.
FOWLER: second frontal convolution.
GRATIOLET, RICHET: deuxième circonvolution frontale.
HUXLEY: gyrus medio-frontal.

III. LOBULUS FRONTALIS INFERIOR.

ECKER: gyrus frontalis tertius s. inferior.
BISCHOFF: dritte Stirnwindungsgruppe.
HENLE: unterer gyrus frontalis g. transitions (nach Huschke).
BROCA: troisième circonvolution frontale.
TURNER: inferior frontal gyrus.

Huguenin: erste Stirnwindung.
Lussana e Lemoigne: circonvoluzione spirale.
Ferrier: inferior frontal convolution. Broca's conv.
Fowler: second frontal convolution. Broca's conv.
Gratiolet, Richet: troisème circonvolution frontale.
Huxley: gyrus infero-frontal.

IV. Lobulus Rolandicus anterior.

Pansch: gyrus Rolandicus anterior.
Ecker: gyrus centralis anterior.
Bischoff: vordere Centralwindung.
Henle: gyrus centralis anterior.
Broca: circonvolution prerolandique.
Turner: ascending frontal gyrus.
Fowler: ascending frontal convolution.
Ferrier: anterior central convolution.
Huguenin: vordere Centralwindung.
Lussana e Lemoigne: circon. parietale anteriori.
Valentin: gyrus adplicatus anterior.
Richet: circon. frontale ascendente.
Pozzi: quatrième circon. frontale.
Rolando: processi anteroidei verticali di mezzo (partie anteriore).
Huxley: gyrus antero-parietal.
Gratiolet: première pli pariétal ascendant.

The division of the preceding group is conformable to the majority of authors. Pansch, in consequence of joining the præcentral and second frontal sulci, re-arranged these convolutions on rather an inconvenient plan. His names, however, for the portions contiguous to sulcus Rolando, are very expressive.

V. Lobulus Rolandicus posterior.

Pansch: gyrus Rolandicus posterior.
Ecker: g. centralis posterior.
Bischoff: hintere Centralwindung.
Henle: g. centralis posterior.
Broca: circonvolution postrolandique.
Turner: ascending parietal gyrus.
Huguenin: hintere Centralwindung.
Lussana e Lemoigne: circon. parietale posteriore lunga.
Valentin: gyrus adplicatus posterior.
Richet: parietale ascendente circon.
Ferrier: posterior central convolution.
Fowler's Charcot: ascending parietal convolution.

VI. Lobulus parietalis superior.

Pansch: gyrus parietalis superior.
Ecker: lobulus parietalis superior.
Bischoff: Vorzwickel und innere obere Scheitelbogenwindung.

HENLE: præcuneus.
BROCA: première circon. pariétale.
TURNER: postero-parietal lobule.
FERRIER: superior or postero-parietal lobule.
FOWLER: superior parietal lobule.
RICHET: lobule pariétal superieur.
HUGUENIN: dritte Scheitelwindung.

VII. LOBULUS PARIETALIS INFERIOR.

PANSCH: lobulus parietalis inferior.
ECKER: lobulus p. inf., a. lob. supramarginalis, b. gyrus angularis.
BISCHOFF: vordere und mittlere Scheitelbogenwindung.
HENLE: lobulus tuberis.
BROCA: deuxième circonvolution pariétale.
TURNER: lobule of the supra-marginal convolution and angular gyrus.
RICHET: lobule parietal inferior et pli courbe.
FERRIER: inferior parietal lobule, gyri supramarg. et ang.
LUSSANA e LEMOIGNE: lobo quadrangolore.
HUGUENIN: erste und zweite Scheitelwindung.
FOWLER: inferior temporal lobule, lobulus parietalis inferior et gyrus angularis.

One of the advantages of distinguishing between gyrus and lobulus is apparent in this convolution, where some authors locate two lobules in one gyrus, two gyri in one convolution or lobule, and even a lobule and gyrus in a convolution called a gyrus.

VIII. LOBULUS TEMPORALIS SUPERIOR.

PANSCH: lobulus temporalis superior.
ECKER: gyrus temporalis superior.
BISCHOFF: erste obere Schläfenwindung.
HUGUENIN: erste Schläfenwindung, gyrus temporalis I.
BROCA, RICHET: première circon. temporale.
TURNER: superior temporo-sphenoidal convolution.
FERRIER: first temporo-sphenoidal convolution.
LUSSANA e LEMOIGNE: prima circonvoluzione temporali.
FOWLER: first temporal convolution.

IX. LOBULUS TEMPORALIS MEDIUS.

PANSCH: upper half of lobulus temporalis inferior.
ECKER: gyrus temporalis medius.
BISCHOFF: zweite mittlere Schläfenwindung.
HENLE: unnamed, but indicated.
BROCA: deuxième circonvolution temporale.
TURNER: middle temporo-sphenoidal convolution.
HUGUENIN: zweite Schläfenwindung, gyrus temporalis II.
LUSSANA e LEMOIGNE: secondo circon. temporali.
GRATIOLET: pli temporal moyen.
VALENTIN: supplementum gyri anguiformis post. et inf.

As previously mentioned under Sulci, Pansch unites this lobule with the following under the name of lobulus temporalis inferior, which is not done by any other investigator.

X. Lobulus temporalis inferior.

Pansch: gyrus temporalis lateralis.
Lussana e Lemoigne: terza circon. sfeno-temporali.
Gratiolet: pli temporal inferiéur.
Rolando: processo semi duplicato del lobo di mezzo.

The others invariably follow the order indicated above, with the substitution of troisième, inferior or third as prefix. Pansch attaches this as a gyrus to the lobulus occipito-temporalis lateralis.

B. MEDIAN SURFACE.

XI. Lobulus marginalis.

Pansch: gyrus medialis fronto-parietalis of the lobulus medialis anterior.
Ecker: g. frontalis superior, mediale Fläche.
Bischoff: Innenfläche des ersten Stirnwindungszuges und obere Bogenverbindung der Centralwindungen.
Broca: première circon. frontale.
Turner: marginal gyrus.
Richet: face moyenne de la première circon. frontale.
Lussana e Lemoigne: cintura periferica.
Huxley: marginal convolution.

The title Turner gives this portion seems as expressive as any, and decidedly shorter.

XII. Lobulus fornicatus.

Pansch; gyrus cinguli of the lobulus medialis anterior.
Ecker: gyrus fornicatus und præcuneus.
Bischoff: gyrus fornicatus.
Broca: grande circonvolution du corps calleux.
Turner: conv. of corpus callosum and quadrilateral lobule.
Huguenin: gyrus fornicatus.
Fowler: conv. of corpus callosum.
Lussana e Lemoigne: processo quadrilatero e circonvoluzione madre-interna-dell' orletto.
Valentin: circonvolutio cristata.
Richet: præcuneus et gyrus fornicatus.

The ancient title, fornicatus, refers to the arched shape of this lobule, and not to its being near the fornix, and by this name the convolution is generally known to anatomists. For this reason it should be retained.

XIII. Lobulus cuneus.

Pansch: lobulus medialis posterior, gyrus medialis occipitalis s. cuneus.
Ecker: gyrus cunei.

HENLE: cuneus.
BROCA: lobule triangulaire.
TURNER: cuneus or occipital lobule.
BISCHOFF: Zwickel.
LUSSANA e LEMOIGNE: circon. angolare occipitale.

XIV. LOBULUS OCCIPITO-TEMPORALIS MEDIALIS.

PANSCH: lobulus occipito-temporalis medialis.
ECKER: gyrus occipito-temporalis medialis, gyrus Hippocampi.
BISCHOFF: unterer innerer Hinterhauptwindungszug und gyrus Hippocampi.
HUSCHKE: lobulus lingualis.
HENLE: gyrus Hippocampi.
HUGUENIN: Zungenwindung.
BROCA: cinquième circonvolution temporale.
TURNER: uncinate gyrus, middle internal temporal gyrus.
RICHET: gyrus hippocampi et g. uncinatus et lobulus lingualis.
FERRIER: g. uncinatus, uncus gyri fornicati, subiculum cornu ammonis and crochet with gyrus occipito-temporalis medialis (lobulus lingualis).
FOWLER'S CHARCOT: Unciform and hippocampal convolutions.

By including all that portion of the brain lying beneath the fissura calcarina from the occipital to the temporal extremities into one lobule, bounded below by the fissura collateralis, and designating the smaller important points as gyri, avoids much mislocation and confusion. While there has been perfect agreement as to portions, hereabouts, there has been total want of unanimity as to terms, the same names being applied to different parts. The designation of Pansch is complete. On page 58 of Fowler's Charcot, in Fig. 17, representing the vascular territories of the inferior face of the human brain, the median and lateral temporo-occipital convolutions are erroneously transposed.

C. BASILAR SURFACE.

XV. LOBULUS OCCIPITO-TEMPORALIS LATERALIS.

PANSCH: gyrus occipito-temporalis lateralis.
ECKER: gyrus occipito-temporalis lateralis.
BISCHOFF: unterer äusserer Hinterhauptwindungszug und ein Theil der dritten Schläfenwindung.
HUSCHKE: gyrus fusiformis.
BROCA: quatrième circonvolution temporale.
TURNER: inferior internal temporal gyrus.
FERRIER: gyrus occipito-temporalis lateralis (fusiformis).
RICHET: g. occipito-temporalis, lobulus fusiformis.
LUSSANA e LEMOIGNE: processo fondamentale posterior.
FOWLER'S CHARCOT: oc-temp. lat. convolution (medialis, p. 58, error).
HUGUENIN: Spindelwindung.

XVI. LOBULUS ORBITALIS.

Pansch does not name the sulcus between the middle and lateral gyri in this lobule. All others do, and one adds a sulcus too many. The name of this lobule is uniformly the same among authors.

GYRI.

EXTERNAL SURFACE.

a. GYRUS OPERCULUM.

GRATIOLET: pli surcilier.

VARIOUS: Operculum; klappdeckel; opercule; l'opercolo; coperchio; convolution of Broca; circonvolution spirale; roof of Island of Reil.

b. GYRUS SUPRA-MARGINALIS.

GRATIOLET: lobule du pli courbe.

VARIOUS: supra-marginal lobule or gyrus.

LUSSANA e LEMOIGNE: circonvoluzione marginale.

HUSCHKE: lobulus tuberis.

c. GYRUS ANGULARIS.

GRATIOLET: pli courbe.

FERRIER, HUXLEY: angular gyrus.

Gyri *b* and *c* are not separate in the ape.

d. GYRUS OCCIPITALIS PRIMUS.

e. GYRUS OCCIPITALIS SECUNDUS.

f. GYRUS OCCIPITALIS TERTIUS.

These are the three "bridging convolutions" or "plis de passage" to which term Ecker objects, calling them first, second and third occipital gyri, as above. Huxley writes of them as annectant external gyri. Lussana and Lemoigne call them "gyri abrupti e cuneiformes, piega occipitale de passagio."

MEDIAN SURFACE.

g. GYRUS UNCINATUS.

Usually mentioned with many names by each writer: gyrus uncinatus; crotchet; gyrus Hippocampi; uncus gyri fornicati; subiculum cornu ammonis; cornu ammonis; the hook or reduplication of the uncinate gyrus.

h. GYRUS DENTATUS.

The hippocampal gyrus of some authors. The fascia dentata bordering the hippocampus major, or investing *corps godronné* suggesting the title.

j. GYRUS PARACENTRALIS.

Named by Betz, who, with Mierzejewski, discovered here the presence of comparatively enormous pyramidal cells, called "giant cells" from their size. Ferrier locates in this vicinity, the psycho-motor centres of the limbs. A sulculus is noticed in this gyrus, mentioned as the transverse furrow of the paracentral lobule.

k. GYRUS PRÆCUNEUS.

The quadrilateral lobule or præcuneus: avant coin; Vorzwickel. Considering the Greek origin of the word gyrus, quadrilateral gyrus, or four-sided circle would amount to an etymological squaring of the circle.

l. GYRUS DESCENDENS.

Between the rami of the fissura calcarina.

BASILAR SURFACE.

m. GYRUS RECTUS.

n. GYRUS ORBITALIS MEDIUS.

o. GYRUS ORBITALIS LATERALIS.

INSULA.

Island of Reil, which might be classed among the lobules as lobulus insulæ. Ecker prefers "lobus centralis." Spitzka suggests a suitable nomenclature applicable to comparative encephalic anatomy, in the JOURNAL OF NERVOUS AND MENTAL DISEASE, July, current series. Spitzka's article is a valuable addition to our literature and knowledge of the insula. He objects to naming the shallow groove of a turtle's or serpent's brain, island or fossa, although homologous with the insula, and uses the term "fovea centralis," which applies to all true reptiles and birds; "fossa centralis" for its further development in rodentia, insectivora and marsupialia; "lobus centralis" where the surrounding convolutions overlap the retracted area. The Insula contains the three GYRI BREVES or OPERTI.

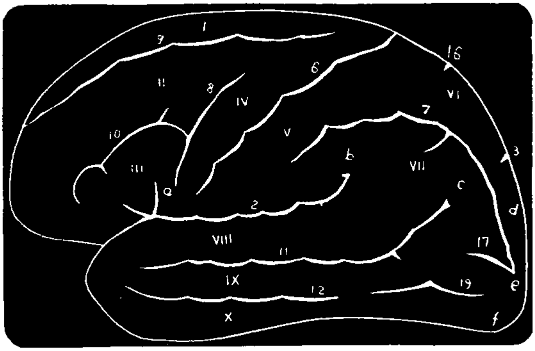
They lie within the lips or borders of the fissura Sylvii concealed by the gyrus operculum, which on its under surface contains gyri dovetailing between the gyri breves *in situ.*

The insula may also be described as lying between the operculum externally and the extra-ventricular nucleus of the corpus striatum internally.

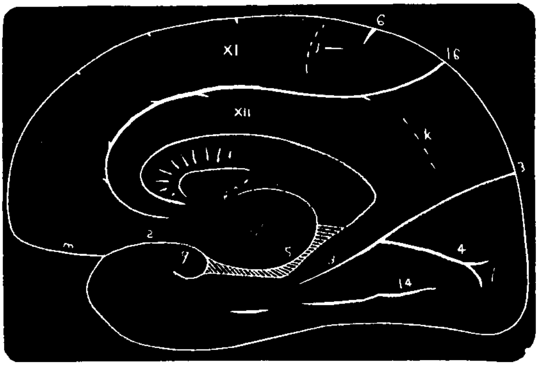
Gratiolet et Leuret, planche XVII., illustrate this "central lobule" or "plis rayonnants de l'Insula" as having four gyri or "*circonvolutions disposées en manière d' éventail' et se continuant avec les plis superficiels de l' hémisphère.*

I would suggest from their positions for the principal or more evident three: *Gyri breves: anterior, medius, posterior.*

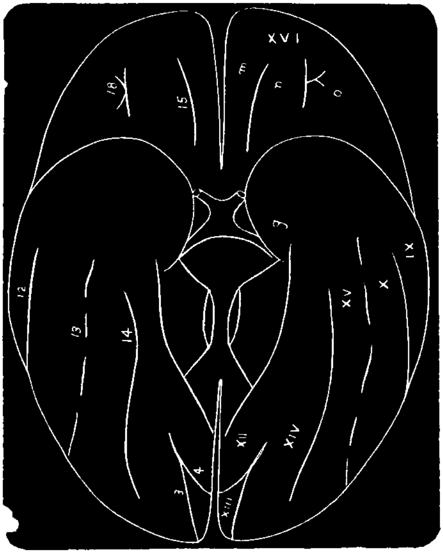
Where extra gyri require mention we happily have a means of clearly designating them. The typical middle cerebral or Sylvian artery at this point divides into four branches, which lie in the sulci separating the gyri breves. It is evident that



Cut A. External Surface.



Cut B. Median Surface.



Cut C. Basilar Surface.

four arterial branches can include but three gyri, hence additional undulations must be attached, or referable in some way, to these three principal divisions.

POSITIONS.

In the three preceding cuts the Roman numerals refer to the lobules as numbered, *seriatim*, in the paper. The Arabic numerals are intended to represent the fissures, up to five, and thereafter the sulci; the "lower case" letters are placed over the gyri; and each number and letter may be referred to under respective headings: Lobules, Fissures, Sulci, Gyri.

It would be out of place and presumptuous to attempt a digest of what has been done in the field of localization in a simply topographical essay, particularly as the topography is what the term implies—a simple survey of the outer configuration of the cortex of the cerebrum. Still, I think it would be practicable and interesting to note, *en passant*, such matters of physiological, anatomical or pathological importance as have been evolved by the exact, cautious and conscientious experimenters and observers of many nationalities. It is necessary, then, to resume and locate as clearly as possible each furrow and convolution:

1. *Fissura longitudinalis.*—Divides the cerebrum into two hemispheres, antero-posteriorly, except where the right and left lobes are joined by the corpus callosum, the great transverse commissure which links the two sides symmetrically into a physiological whole. To exhibit the entire median surface, an incision is carried downward between the anterior cerebral arteries, through the corpus callosum; septum lucidum, exposing the fifth ventricle; fornix, when the Venæ Galeni and velum interpositum come into view, with the anterior commissure behind a band of fibres, connecting the genu of the corpus with the optic chiasma, the dipping anterior pillar of the fornix blending downward to its corpus mammilarius. Behind this the foramen of Monro and upper part of the thalamus opticus, with the pineal gland, appear. Carrying the incision down about two lines, the middle or soft commissure is cut through, and the connected posterior commissure, pineal gland, and quadrigeminal body are divided,

the scalpel falling into the aquæductus Sylvii and third ventricle.

Dividing the optic decussation and pituitary body, completes the separation, and we have the median surface exposed.

16. *Sulcus calloso-marginalis.*—Begins under the genu of the corpus, and running nearly parallel with the upper margin of this great band of fibres, courses posteriorly, and ends as a notch on the lateral parietal surface.

5. *Fissura hippocampi.*—Runs between the posterior border of the fornix to the hook or crotchet, which forms the gyrus uncinatus in the temporal lobe.

3. *Fissura occipitalis.*—Begins behind the last mentioned, with which it is confluent in the ape, but separately existent in man, runs directly and nearly perpendicularly backward, bending over the latero-median border, and ending as does the calloso-marginal sulcus. In the ape it is prolonged on the occipito-parietal lateral surface.

4. *Fissura calcarina.*—Branches from the last, near its anterior extremity, and passing horizontally backward, parts into two rami, ascendens et descendens, on the occipital extremity.

14. *Sulcus collateralis.*—Lies under, and somewhat parallel to, the preceding, marking externally the position of the eminentia collateralis, and separating the posterior portion of the median from the basilar surface.

XI. *Lobulus marginalis.*—Is bounded by the latero-median crest, anteriorly and superiorly, and by the sulcus 16, posteriorly and inferiorly. Just anterior to the median termination of the sulcus Rolando in this lobule are the *sulculus paracentralis transversus* and the *gyrus paracentralis*, which surrounds it.

XII. *Lobulus fornicatus.*—Directly under XI. and above the corpus callosum, which, with 3 and 5, form its lower boundaries, the latero-median ridge completing the posterior separation from other lobules.

The posterior portion of XII. includes the *gyrus præcuneus*, a quadrangular part separated by sulculi from the lobule proper.

XIII. *Lobulus cuneus.*—A triangular portion of the occipital extremity, included between the fissures 3 and 4. Regarding the ramus descendens as the nethermost part of 4, causes the *gyrus descendens* to be located in XIII.; though in many brains it may apparently be a portion of the lobule immediately below.

XIV. *Lobulus occipito-temporalis medialis.*—Extends from the occipital to the temporal extremity, beneath the fissures 2, 5 and 4. Accessory sulculi have to be called into requisition to complete the lower boundary, as the sulcus collateralis does not extend into the temporal extremity. An important *gyrus*—the *uncinatus*—formed like a hook, is found near the anterior perforated space in this lobule.

2. *Fissura Sylvii.*—Begins at the gyrus uncinatus, and separating the hemisphere into upper and lower portions or lobes, the frontal and temporal runs nearly horizontally backward to the postero-parietal part of the lateral surface, where it ends in the *gyrus supra-marginalis;* within this fissure, and just beneath the *gyrus operculum*, formed by the *ascending ramus* of the fissura Sylvii and sulci posterior to it, lie the *gyri breves*, *anterior*, *medius et posterior*, previously described as belonging to the *insula* or *island of Reil.*

6. *Sulcus Rolando.*—Begins at the median edge, superiorly, about midway between parts corresponding to the anterior and posterior borders of the parietal bone, thence vertically forward and downward, nearly to the fissura Sylvii.

9. *Sulcus frontalis superior.*—Commences anterior to 6, passes forward nearly parallel to 1, tending toward the median surface, probably, in most brains, and breaks up into sulculi on the superior orbital extremity.

10. *Sulcus frontalis inferior.*—Either as a continuation of 8, or at right angles to it, nearly parallel to the previously mentioned sulcus 9, ends similarly in sulculi, usually on the latero-posterior part of the orbital extremity.

8. *Sulcus præcentralis.*—A short sulcus, anterior and running nearly parallel to 6, ending in, or passing at, right angles to 10.

7. *Sulcus parietalis.* — On the superior postero-parietal region, for a short space in the same direction with 6, but bends downward and to the median line, ends on the occipital

extremity, a little below where fissure 3 emerges from the median surface.

11. *Sulcus temporalis superior.*—From the temporal extremity backward, parallel to fissure 2, ends in the *angular gyrus*, just short of sulcus 7, at the occipito-parietal junction. This sulcus and fissure 2 are confluent and identical, posteriorly, in the simian; hence, the two gyri formed by them in the human brain, form but one in the ape's.

12. *Sulcus temporalis medius.*—Below and parallel to the preceding anteriorly, but ends abruptly in sulculi, before reaching the occipital extremity.

17. *Sulcus occipitalis transversus.*—Might be considered, and probably is, in many instances, a ramus projected forward from the occipital termination of sulcus 7.

19. *Sulcus occipitalis longitudinalis inferior.*—A shorter sulcus than its name would seem to indicate, with as much disparity between size and title as exists in musculus levator labii superioris alæque nasi. This sulcus is on the infero-lateral occipital extremity below sulcus 17, and could be made continuous with 12 by means of intervening sulculi.

I. *Lobulus frontalis superior.*—Anterior to sulcus 6, and superior to 9, extends to orbital extremity.

II. *Lobulus frontalis medius.*—Bounded anteriorly by orbital extremity, posteriorly by sulcus 8, above and below by sulci 9 and 10.

III. *Lobulus frontalis inferior.*—Between sulcus 8 posteriorly, 10 superiorly, fissure 2, and orbital extremity infero-anteriorly.

IV. *Lobulus Rolandicus anterior.*—In front of the sulcus 6, behind sulcus 8, and separated from lobules I. and II. by sulculi or imaginary lines.

V. *Lobulus Rolandicus posterior.*—Behind sulcus 6, separated from posterior lobules by fissure 2 and sulculi projected superiorly from it into the sulcus 7, and thence toward the median edge.

VI. *Lobulus parietalis superior.*—Posterior to V., and between sulcus 7 and latero-median edge or margin, generally described as ending at the point of emergence of fissure 3, but, to avoid multiplying lobules on the occipital extremity, continued to the end of sulcus 7, leaving the *gyrus occipitalis primus* included in this lobule at its posterior border.

VII. *Lobulus parietalis inferior.*—Beneath the sulcus 7 from V. to sulcus 17. I would recommend omitting this lobule altogether in future, and leaving off the word superior from its companion lobule above. Lobules VIII. and IX. could thus include all the parietal portion up to sulcus 7. As it is, an imaginary line running at right angles to the ends ot sulcus 11 and fissure 2 must be projected to meet sulcus 17, which, by the plan mentioned, would be avoided. Still greater ambiguity in the location of this lobule exists in authors projecting it anteriorly into lobule V., from which it can be divided by nothing but sulculi.

VIII. *Lobulus temporalis superior.*—Between fissure 2 and lobulus VII., superiorly and sulcus 11 inferiorly, ends anteriorly in temporal extremity.

IX. *Lobulus temporalis medius.*—Bounded above by sulcus 11, postero-inferiorly by lobulus VII. and sulcus 12, and sulculi extending to sulcus 19.

X. *Lobulus temporalis inferior.*—Extends from the temporal to the occipital extremity, lying between the sulci 12 and 13 in front, and 19 and sulculi projected backward from 13 behind.

The gyri remaining to record on the lateral surface are the three on the occipital extremity:

Gyrus occipitalis primus at the lower end of the lobule VI.

Gyrus occipitalis secundus.—Between sulci 17 and 19.

Gyrus occipitalis tertius.—Below sulcus 19, occupying the most extreme part of the occipital region.

Posteriorly, these gyri are bounded by fissura 1 or the lateromedian margin.

Upon the base of the brain, the remaining points are:

13. *Sulcus temporalis inferior.*—Midway, parallel to and coextensive with sulci 12 and 14.

15. *Sulcus olfactorius.*—Immediately above the olfactory nerve and bulb.

18. *Sulcus orbitalis.*—Antero-posteriorly on the orbital surface of the orbital extremity, usually with one or more rami.

XV. *Lobulus occipito-temporalis lateralis.*—Between sulci 13 and 14 and extremitates temporalis et occipitalis.

XVI. *Lobulus orbitalis.*—Anterior to temporal extremity on the infero-orbital surface.

m. Gyrus rectus.—Between median margin and sulcus olfactorius.

n. Gyrus orbitalis medius.—Between orbital and olfactory sulci.

o. Gyrus orbitalis lateralis.—Above and external to sulcus orbitalis, blends with lobulus III. on lateral surface and orbital extremity.

The preceding details of cerebral topography warrant the very great labor and the vast amount of polemics, of the numerous investigators in this department of anatomy, in their application to autopsies alone. The inclination, skill and opportunities to make accurate *post-mortem* records of cerebral lesions has existed among surgeons ever since surgery was worthy of the name, but this topographical lore has been slowly evolved, and is slow to find its way into anatomical treatises. Without deploring the opportunities lost by Erasistratus, while dissecting his criminals alive, to have placed the science of localization (Fritsch, Hitzig and Ferrier have made it a science) ages ahead of its present slow but sure progress, we could conceive the value of accurately investigated and recorded cerebral injuries, with *ante-mortem* phenomena, statistically set forth in such works as the Surgical Reports of the late war. But the value of the study becomes more apparent in the revelations made by electrization of the cortex, as practiced upon the lower animals by Fritsch and Hitzig, who, in 1870, published in Reichert and DuBois Reymond's *Archiv*, the results of their experiments, which Ferrier, a little later, verified and announced in English journals. The latter investigator improved upon the method of galvanic stimulation used by the originators, in using the secondary or induced current of DuBois Reymond's inductorium, of the mean battery strength of one Daniell. The primary coil resistance was 1.9 units. Ferrier does not say which unit he means, Siemen's or Ohm's. The former is used largely on the European continent, the latter was established by the British Association. To convert Siemen's into Ohm's, multiply by .9536; Ohm's into Siemen's, 1.0486. This may seem a little hypercritical, but it would have been as well had Ferrier noted which was used. However, at a distance of 8 cm. between the two coils, he obtained a current with a "pungent but bearable taste," when applied to the tip of the tongue. It was this current from blunted electrodes applied to the cortex with which the motions, etc., of the animals were evoked. Misunderstandings and assertions that such currents would be diffused, and criticisms upon his methods finally led Ferrier to inveigh against fixing any standard of galvanization beyond using enough of the secondary *to produce the effects uniformly attainable.* The matter of extra polar conduction was settled in Ferrier's favor.

By the inductive method of reasoning, very much praised and too seldom used, Hughlings Jackson was inspired, before either of these three workers, with the idea he expressed in *Clinical and Physiological Researches on the Nervous System*, that convulsive movements of one side might be due to localized irritation in the opposite hemisphere, and inferred a "discharging" lesion from the cortex. His confreres considered him fanciful and ridiculed his theory. The main points discovered are as follows:

The antero-frontal and occipital regions gave no response to electrical stimulation. The application of the electrodes to the insula, lobulus fornicatus and corpus callosum were similarly negative in effect. The lobulus marginalis coincided in phenomena with the frontal lobule bordering it.

By homology of centres surrounding it, localized by this means, the crucial sulcus of the carnivores corresponds with sulcus Rolando *physiologically.* Anatomically the two are not capable of comparison. It is noteworthy that the sigmoid gyrus at the end of this crucial sulcus is situated in all carnivora far in front in the orbital region superiorly. The significance of this fact seems to have escaped the notice of authors. It is a conveyance forward of psycho-motor centres into a region corresponding to inhibitory functions in the human brain; inhibition appearing to Ferrier to be "a fundamental element in the attentive concentration of consciousness and control of ideation."

As it is neither desirable nor convenient to copy Charcot and Ferrier into these pages, completely and verbatim, I shall try to epitomize interesting appropriate points only.

Behind the parietal ends of sulci 6 and 16 in lobule VI. are situated centres for movements of the opposite leg and foot, such as are concerned in locomotion.

In front of this, extending across sulcus 6 about 2 cm. in the posterior part of lobulus I., various complex movements of the arms and legs as in swimming, climbing, etc. In the monkey the lower part of this area is devoted to tail movements. The evolutionists might look here for apolar or rudimentary cells.

About 2 cm. further forward extends an area devoted to arm and hand extensors, as in reaching forward.

Behind the orbital extremity on lobule I., 3 cm. in diameter, lying partly on lobule II., is a centre for lateral movements of head and eyes, and dilatation of pupil.

Below the posterior end of sulcus 9 in lobulus IV., bicipital supination and flexion of forearm. Thence three centimetres down the same lobulus, centres for elevation and depression of angle of mouth.

On the gyrus operculum, movements of lips and tongue as in articulation. This is the region disease of which causes aphasia, and known as Broca's convolution.

At the lower end of lobulus V., the centre of the platysma, retraction of angle of mouth. Thence up to the first point mentioned on lobulus V. to lobulus VI., centres for hand and wrist movements.

The supra-marginal and angular gyri indicate centres of vision.

Beneath these and upon the posterior portion of lobulus VIII., centres of hearing.

The centre of smell is in the gyrus uncinatus; near it but not exactly defined is a taste centre.

Touch is situated in the middle of lobulus XIV., near fissure 5.

A region "in close relation to the centres of smell and tactile sensation might be regarded as the probable seat of sensations forming the basis of sexual appetite." The occipito-temporal lobules on the basilar surface might fulfill the conditions.

Visceral sensations in the occipital extremity; ablation causing anorexia.

Merely mentioning that corroborative experiments were instituted, by vivisection, to supplement the information obtained through electrical stimulation, we will pass on to the vascular supply.

Heubner and Duret, among the moderns, have done more to forward knowledge of the peculiarities of blood-supply to the brain than any; while Charcot has worked in the field of lesions arising from hemorrhages, embolisms, and softenings producing pareses, paralyses, etc.

We are all familiar with the circle of Willis at the base of the brain, but the books do not follow beyond the main or primary branches given off from the carotid and basilar arteries.

The *anterior cerebral* artery passes into the median surface, runs backward over the corpus callosum, and anastomoses with the posterior cerebral in the occipital region. It gives off three principal branches: the first is distributed to the orbital extremity, the second to the lobulus fornicatus, corpus callosum, marginal lobule, first and second frontal lobules, and gyrus paracentralis. The third branch goes to the gyrus præcuneus, which may be subject to lesions thus on its own account. The *middle cerebral*, or *Sylvian* artery divides into four principal branches, a lesser branch at its origin supplying the central ganglia. The main trunk runs to the Insula, and at that point divides and emerges on the lateral or external face of the brain, between the Sylvian borders. The first branch Duret calls the frontal external and inferior. As it supplies the operculum, many instances of aphasia from its obliteration are on record.

The second branch is the anterior parietal, going to lobulus Rolandicus anterior.

The third ascends the posterior Rolandic lobule.

The fourth branch goes to the gyrus angularis and lobulus temporalis superior.

Softenings in the regions supplied by these arteries have produced the uniform consequences consistent with the function localized in each part. The alteration in the anterior and posterior Rolandic lobules have been invariably followed by paralyses, when the basal ganglia were intact. A softening of the gyrus præcuneus has been followed by nothing noticeable, consistently with Ferrier's experiments.

The middle cerebral is much more frequently the seat of serious alterations than the anterior cerebral artery, "doubtless in part owing to the angle at which the sylvian leaves the internal carotid artery."

"The *posterior cerebral artery* often suffers alterations by embolismus and thrombus.

"Ischæmic softenings of the posterior lobes are much more common than with the anterior lobes." —Charcot, p. 58. Three departments are supplied by this artery: The gyrus angularis; inferior part of the temporal lobe; and lobulus occipito-temporalis lateralis; the third division contains the lobulus occipito-temporalis medialis, lobulus cuneus and occipital extremity, generally.

It is noteworthy that the gyrus angularis receives blood-supply from two sources, which would tend to lessen the chances for amblyopia or hemiopia from cortical lesions.

The literature of this subject cannot be fairly discussed in this article, so with the foregoing mere outlines I will close.

With the desire to "render unto Cæsar," I will repeat that to Pansch I am indebted for the basis of this scheme, and have only departed from his system where other authorities, his collaborators, took issue with him, and their views seemed better.

Wherever an author could be quoted verbatim I have preferred doing so, but generally found it necessary to change the phraseology in condensing.

To Prof. Jewell and Dr. Bannister I am indebted for valuable suggestions and other assistance, and am under especial obligations to the former for the free use of his excellent and extensive library, as well as for having revised this essay. But it is in better taste to thank him for his careful instruction during my pupilage under him, on my own account and for my classmates.